Finding Shower Vertices using a CNN

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ProtoDUNE Reconstruction Meeting

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Introduction

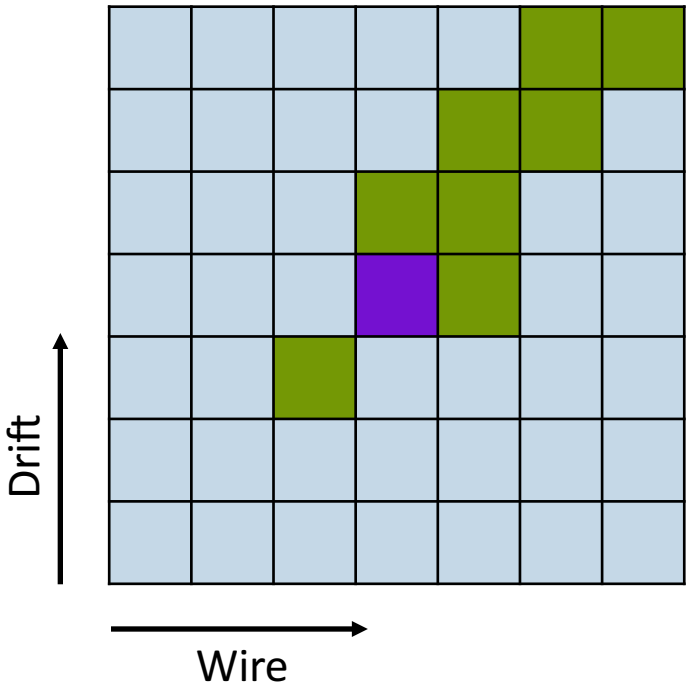
- One of the trickier problems to solve in LAr-TPC reconstuction has been the accurate identification of shower vertices
  - This is vital for high-level tasks such as reconstructing pi-zeros and performing electron / gamma separation
- Seeing the success of the track / shower CNN, we have started to develop a CNN to search for shower vertices.
- Still quite early in the development, but I wanted to outline the ideas and very preliminary results

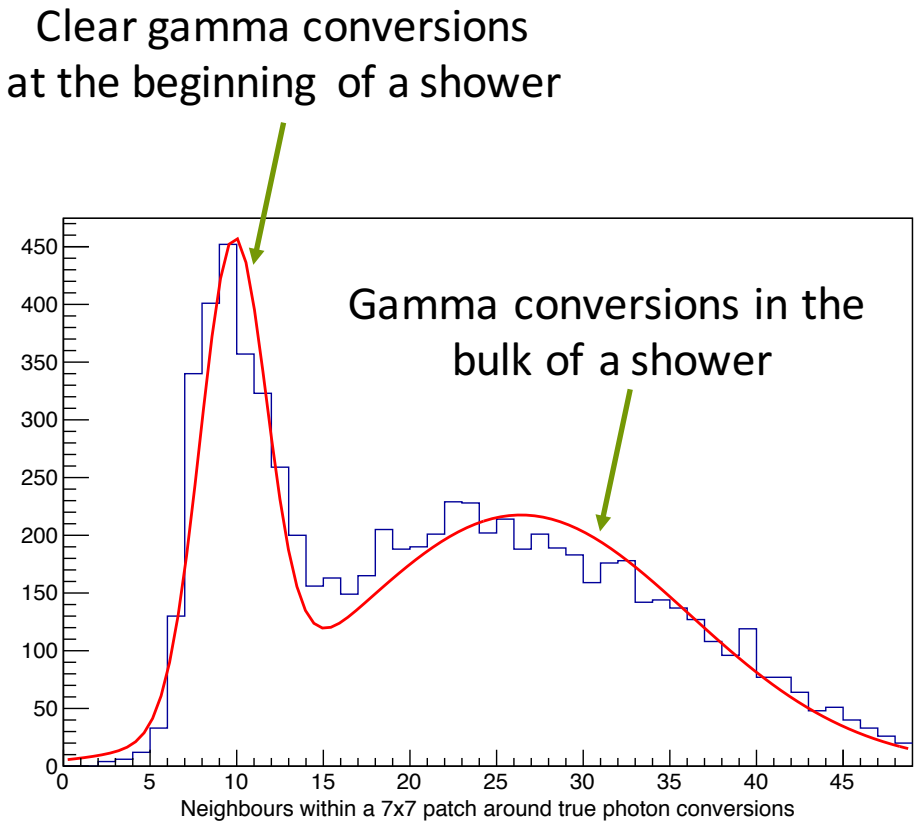
A question of training

- The first job is to define the signal that we need to train on
- I have produced a number of particle-gun pi-zero decays in the TPC
  - Energy of 1 GeV +/- 0.5 GeV
  - This is actually a bit high on average for the energies we can expect, but was just an initial choice
- Then use truth information to select out those spatial points where a gamma conversion occurred
  - Gamma required to have at least 40 MeV energy to be considered

Gamma conversions

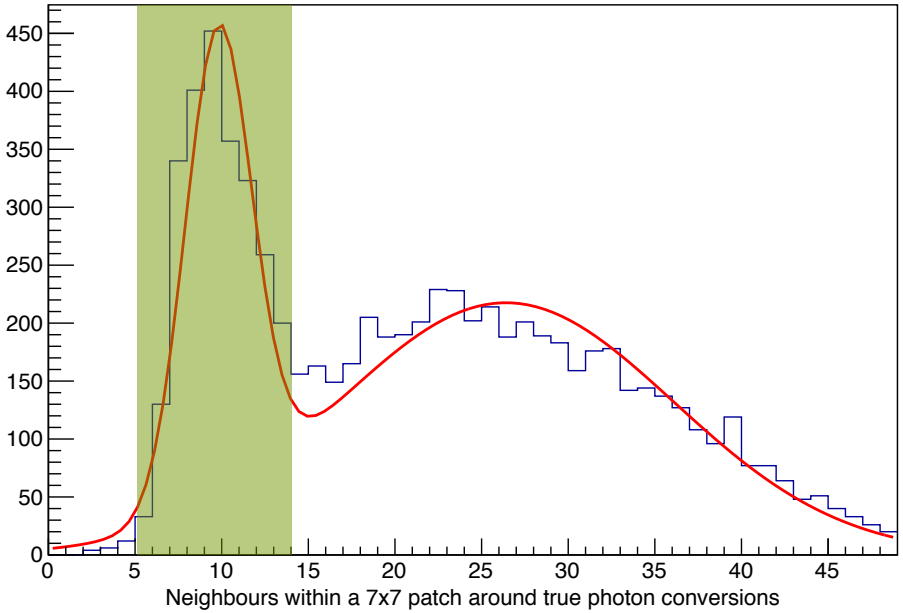
- Look at the number of neighbouring hits to each gamma conversion in a 7x7 grid, and two populations appear:





Gamma conversions

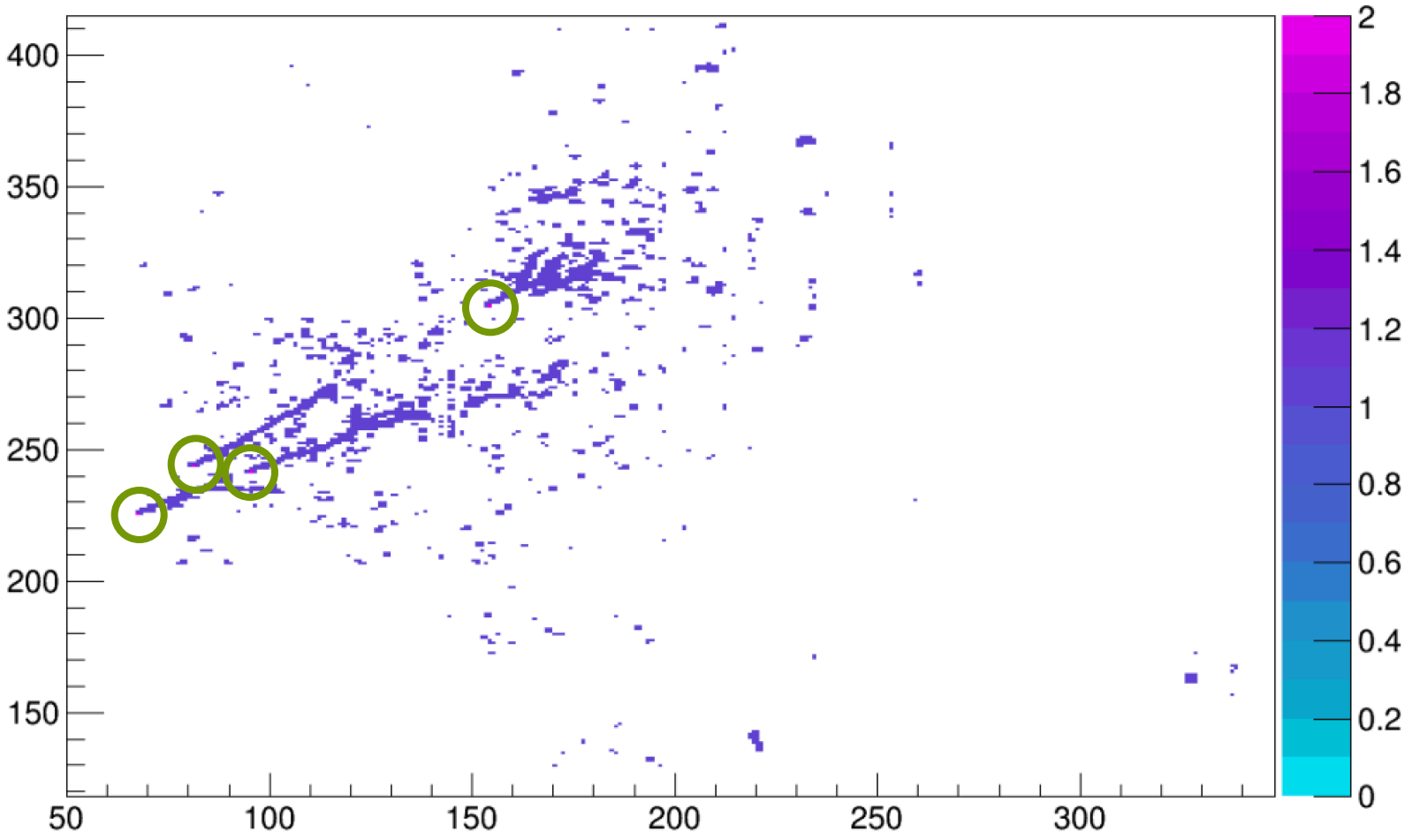
- We want to select this population of gamma conversions at the start of the showers



- Optimised cut selects those with between 5 and 14 neighbours.
  - Optimised using the two Gaussian functions and S/sqrt(S+B) F.O.M.

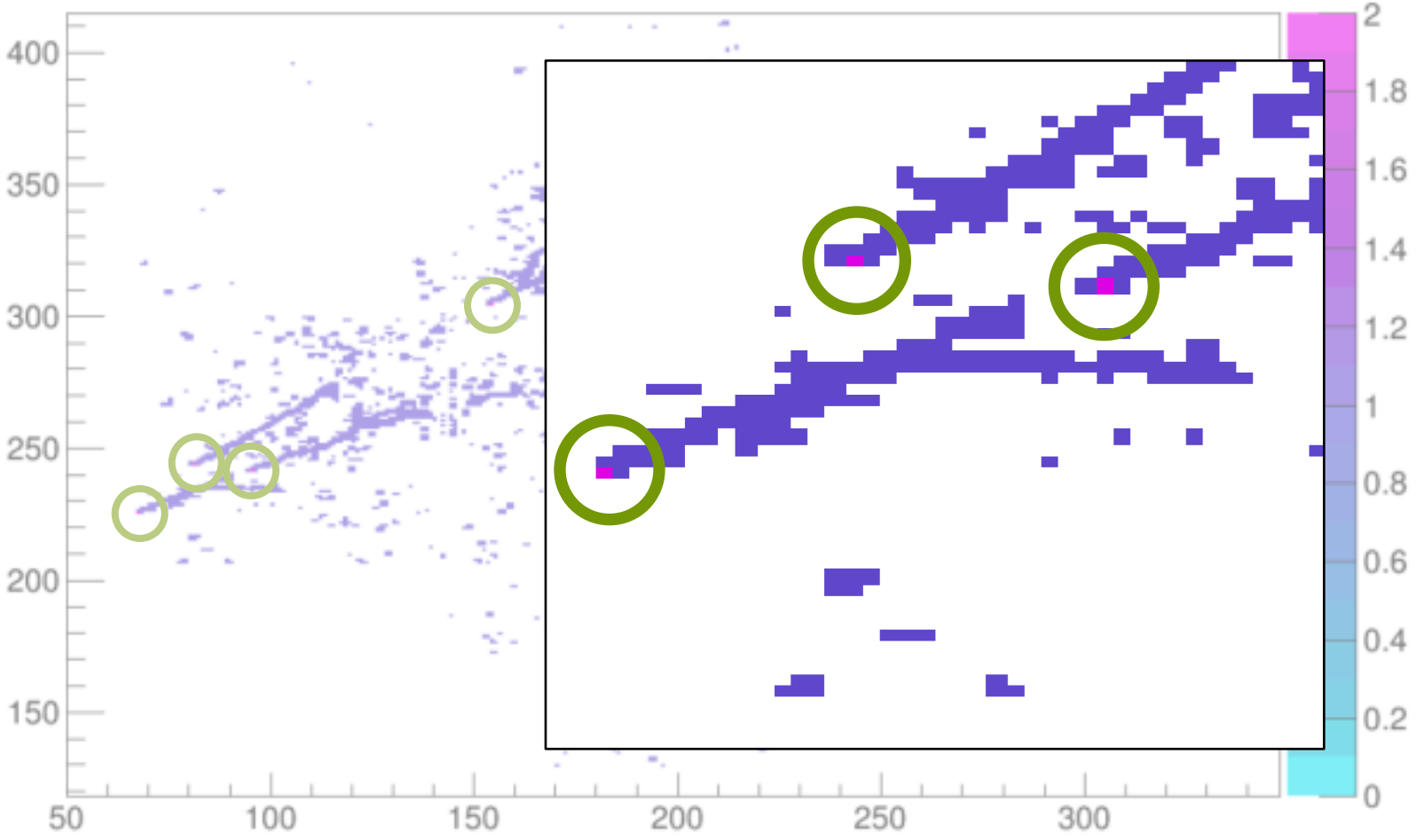
Gamma conversions

- Example of selected gamma conversions:



Gamma conversions

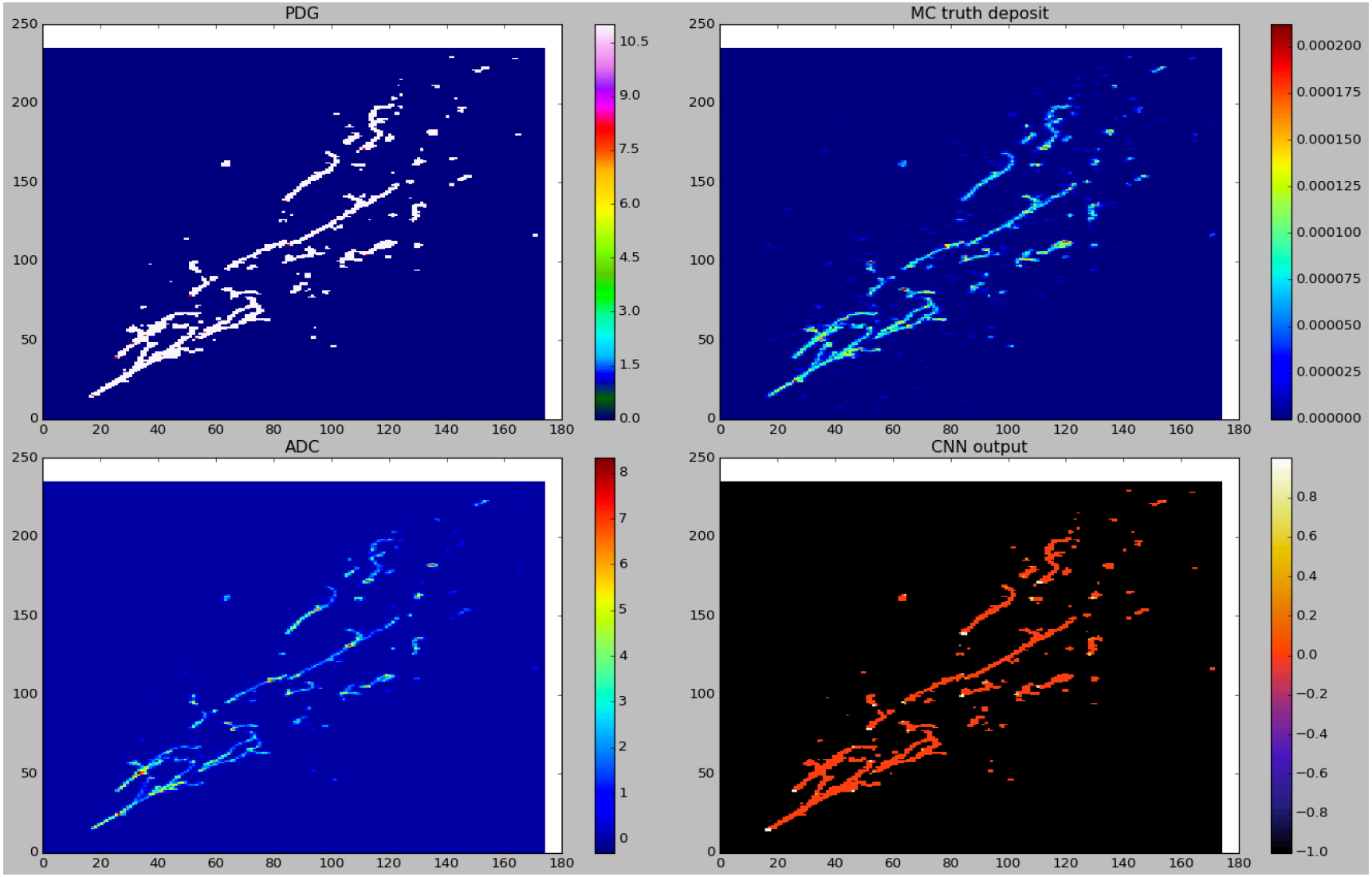
- Example of selected gamma conversions:



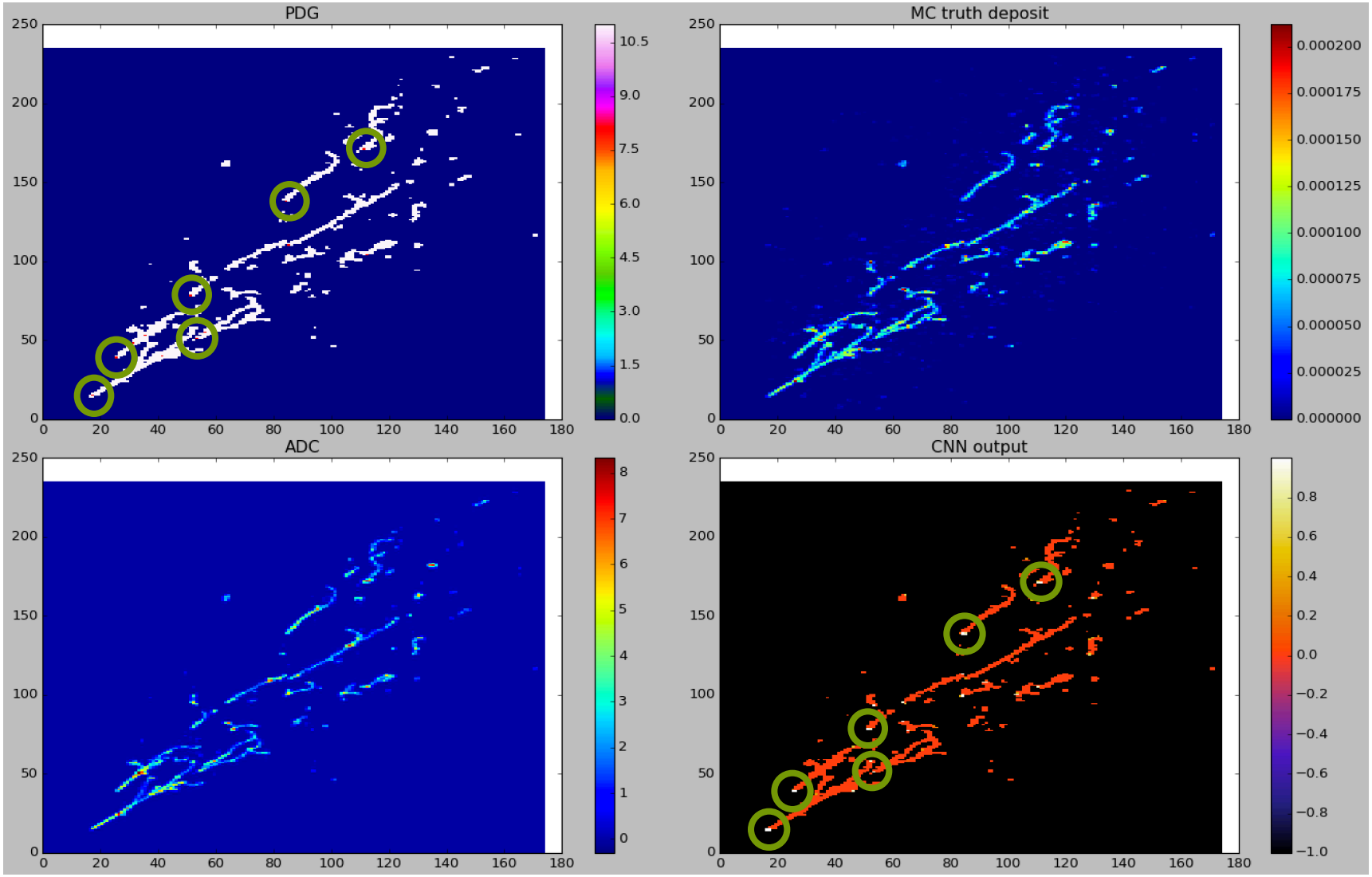
A question of training

- The CNN is trained using the definition of signal given by the number of neighbours
- Background patches for the training come from various parts of the images that are not defined as signal
- Second training was using 300,000 patches
- Network output from 0 to 1, with 1 most likely to be a gamma conversion

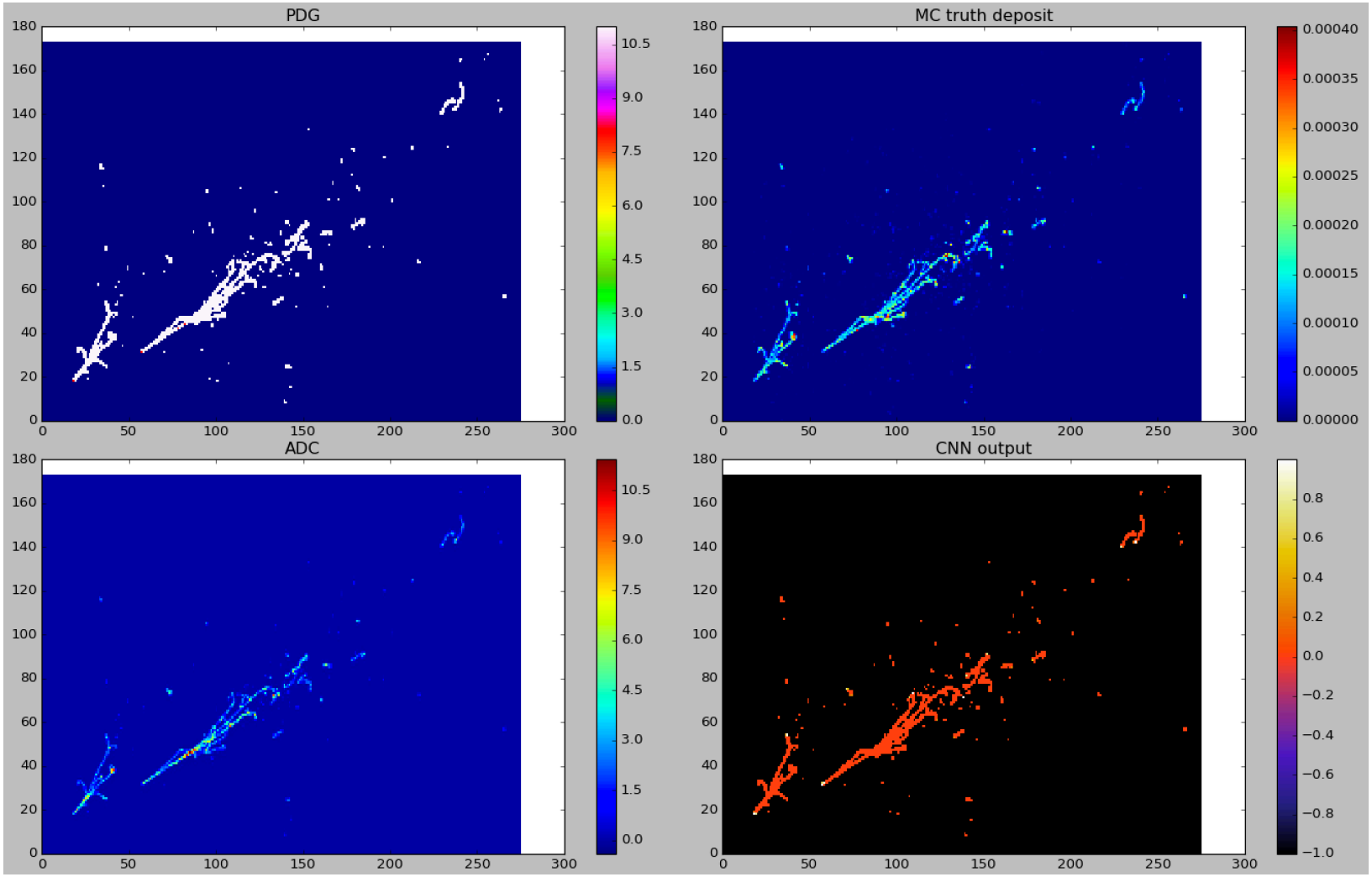
Example Output (1)



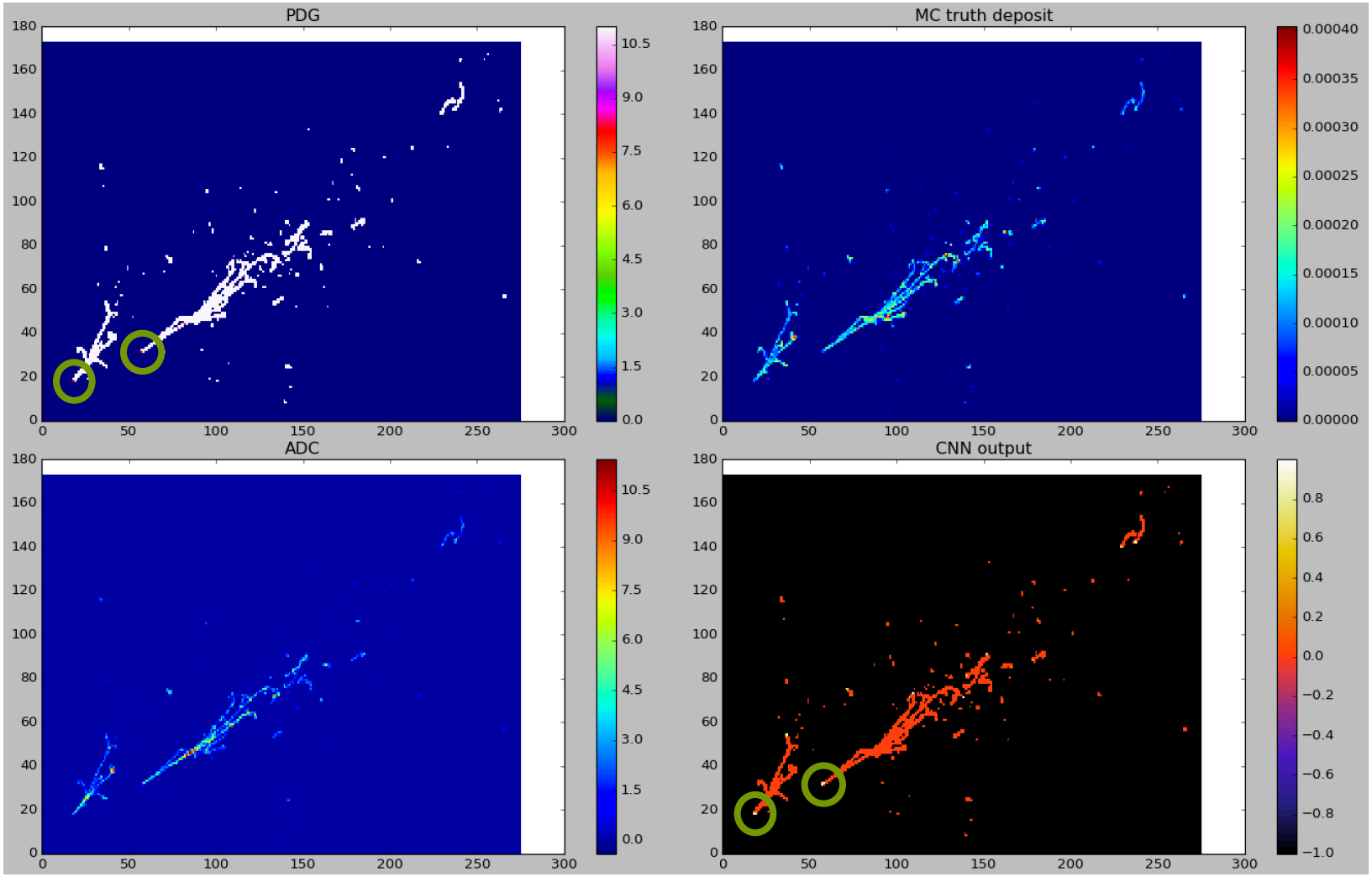
Example Output (1)



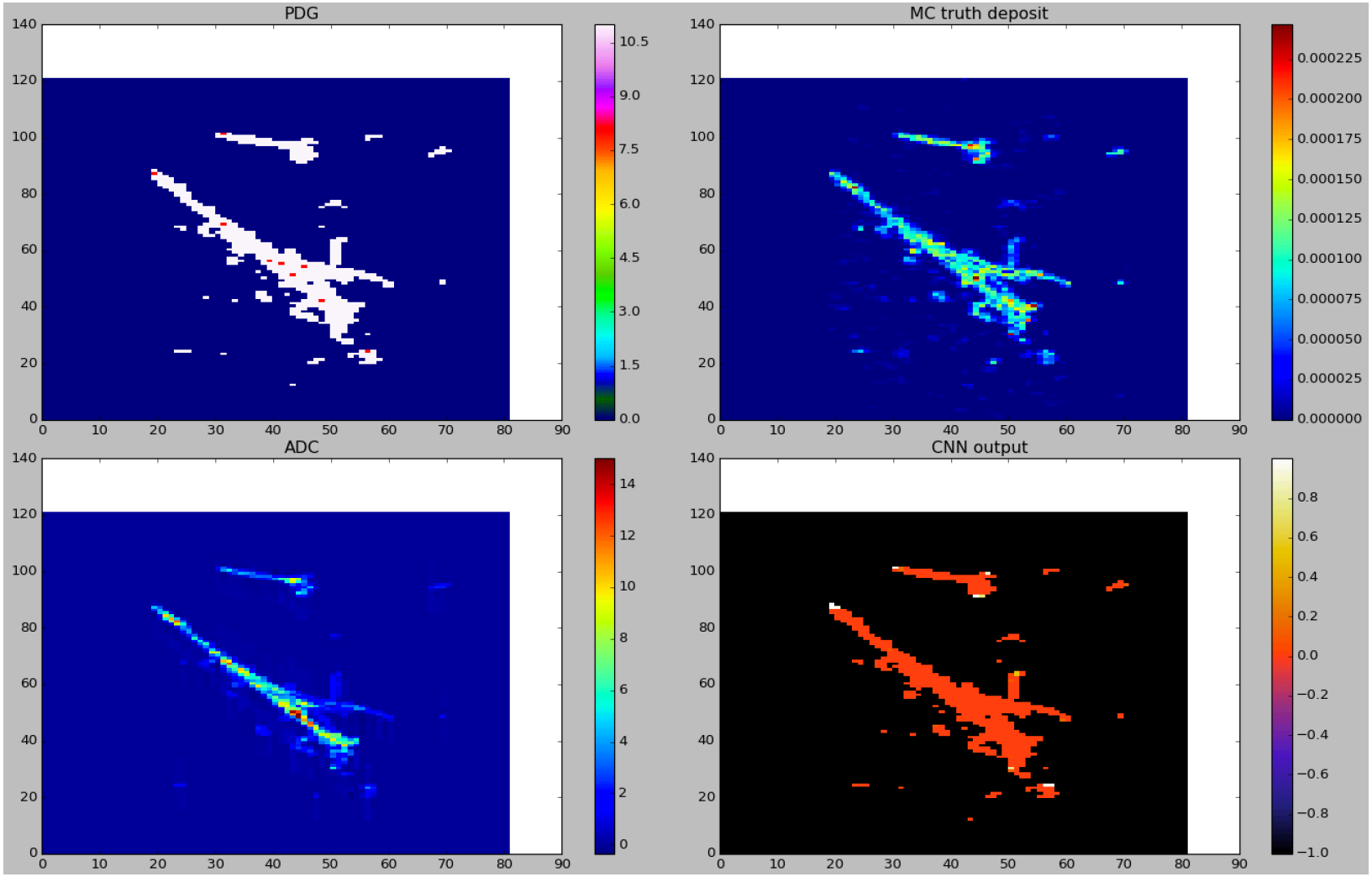
Example Output (2)



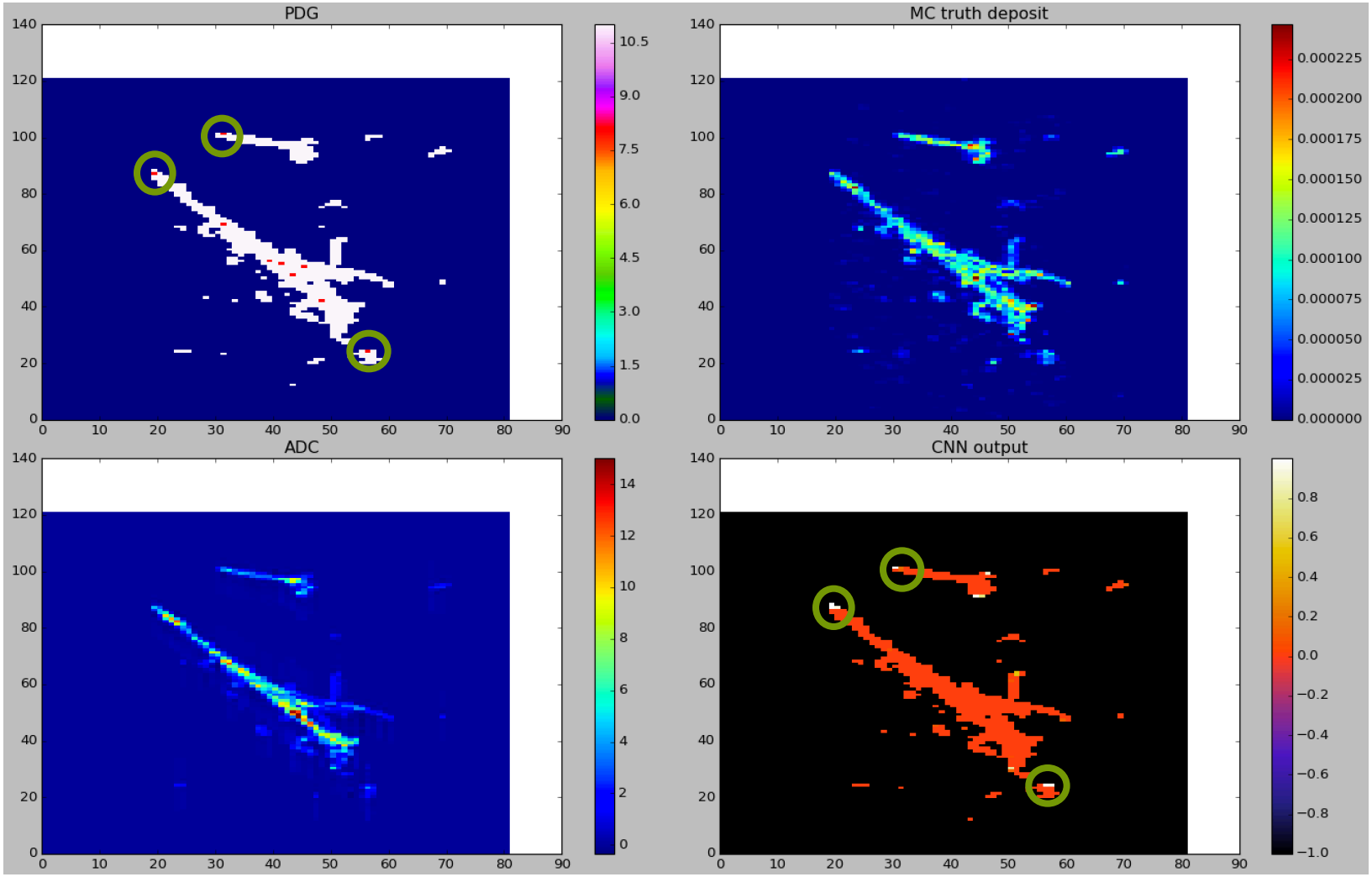
Example Output (2)



Example Output (3)



Example Output (3)

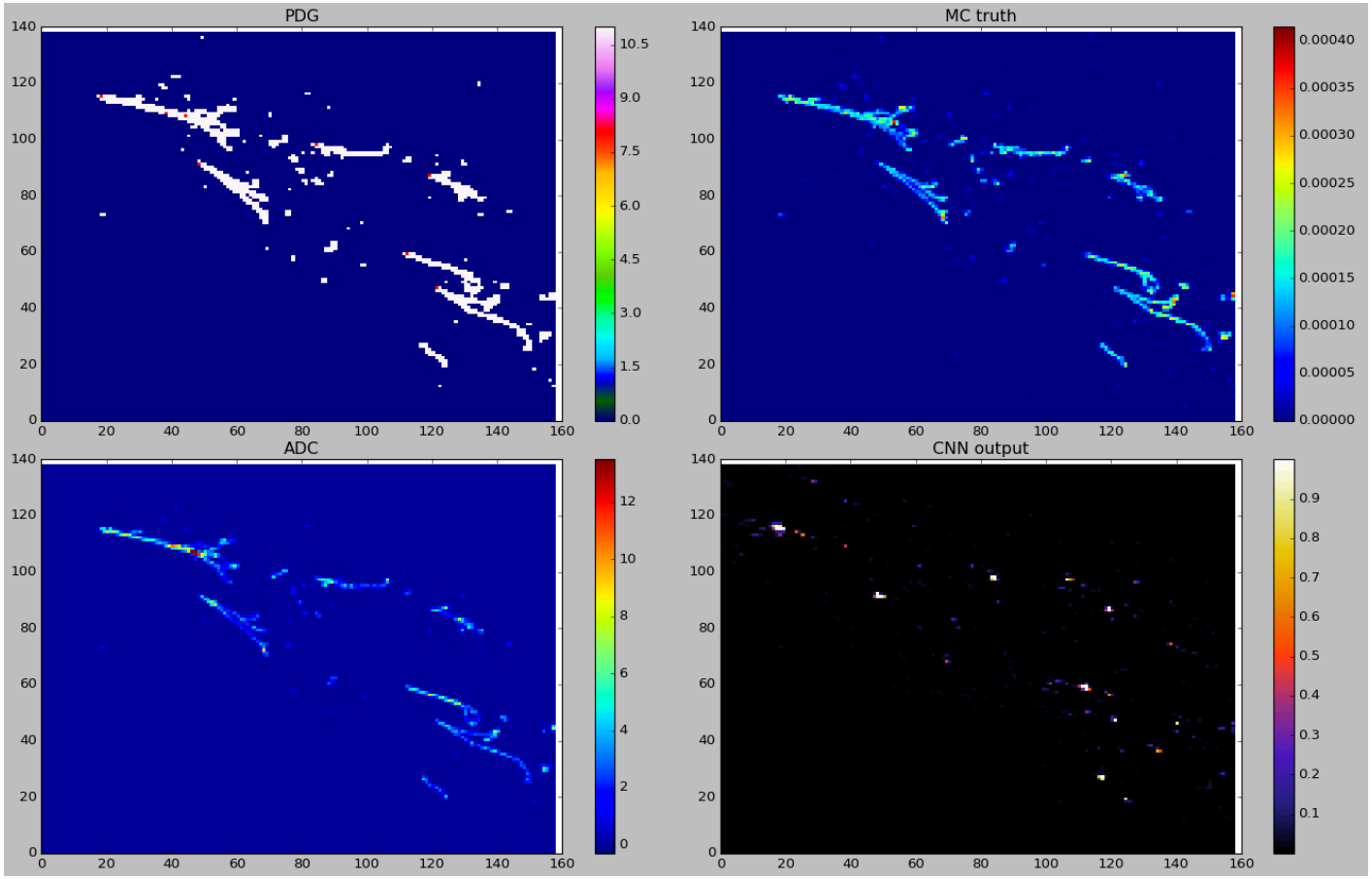


Summary

- Work has begun on training a CNN to identify shower vertices
  - Use the number of neighbours of photon conversions to define the signal
- Initial scans of event displays look promising
  - Some false positives at the end of electron tracks. Will try to include a sample of these labelled as background.
- Now need to work on performance metrics for quantitative measures of how well the network is performing
- Think how to integrate it with the track / shower CNN

Example from first training

- Bright spots in the bottom right identify regions considered likely to be gamma conversion points



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